How Do We Measure Outcomes In NM EOS?

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Disclosures

None related to this talk
Speaker: Depuy/Synthes, Zimmer/Biomet, Nuvasive, Medtronic
Member: PSSG, HSG
Consultant: Nuvasive, Orthobullets
Equity: Orthobullets
Outline

Challenges unique to NM EOS

What are **Goals**?

Outcomes:
- Pulmonary
- Radiographic
- Quality of life
- Surrogates for above?

WHAT DOES QUALITY OF LIFE MEAN TO YOU?

Bellapemo.com
Why Is It So Challenging?
What Are The Challenges of EOS?

Lung development/pulmonary function

Nutritional status

Bone quality/fixation

Kyphosis/PJK

Medical co-morbidities

Others……..
What Are The Challenges of NM Scoliosis?

- Lung development/pulmonary function
- Nutritional status
- Bone quality/fixation
- Kyphosis/PJK
- Medical co-morbidities
- Others....
What Challenges Are The With NM EOS?

- Lung development/pulmonary function
- Nutritional status
- Bone quality/fixation
- Kyphosis/PJK
- Medical co-morbidities
- Others.....
Complications Will Happen

Failure to prepare is preparing to fail.

Benjamin Franklin
Growth Friendly=Complications =Outcome?

- Rod breakage
- Loss of fixation
- Implant prominence
- Infection
- PJK/DJK
- Curve progression
- Autofusion
Obstacles To Measuring Outcomes In EOS
Why Is It So Hard?

Treatment occurs during growth
– Especially rapid spine growth

- FIG. 6. Thoracic spine. The figures are average values.
- FIG. 15. Boys: Diagram of thoracic volume and its evolution expressed as a percentage.
EOS/NM EOS Diversity

Diverse population

Various etiologies
Obstacles To Measuring Outcomes In EOS
Why Is It So Hard?

Variable diagnoses
  – Different skeletal structures
  – Abnormal growth rates
Obstacles To Measuring Outcomes In EOS
Why Is It So Hard?

Surgeon variability
– Indications
– Timing
– Technique
– Execution
What Are Goals?
Achieving Goals = Outcome, Right?

What do we think is important?
- Maximum spine length, residual mobility
- Maximum chest size/function
- Minimum surgeries, hospitalizations
- Minimum complications
- Sitting balance
- Functional outcomes?
- Quality of Life
Recovery Goals Vary By Diagnosis
Assessing Pain Varies By Age/Diagnosis

### Faces Legs Activity Cry Consolability Revised Scale (FLACC-R)

<table>
<thead>
<tr>
<th>Categories</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face</td>
<td>No particular</td>
<td>Occasional grimace or frown, withdrawn, disinterested, sad,</td>
<td>Frequent to constant quivering chin, clenched jaw, distressed</td>
</tr>
<tr>
<td></td>
<td>expression or smile</td>
<td>appears worried</td>
<td>looking face, expression of fright/panic</td>
</tr>
<tr>
<td>Legs</td>
<td>Normal position or</td>
<td>Uneasy, restless, tense, occasional tremors</td>
<td>Kicking, or legs drawn up, marked increase in spasticity, constant</td>
</tr>
<tr>
<td></td>
<td>relaxed, usual tone &amp; motion to limbs</td>
<td></td>
<td>tremors, jerking</td>
</tr>
<tr>
<td>Activity</td>
<td>Lying quietly, normal position, moves easily, regular, rhythmic respirations</td>
<td>Squirming, shifting back and forth, tense, tense/guarded movements, mildly agitated, shallow/splinting respirations, intermittent sighs</td>
<td>Arched, rigid or jerking, severe agitation, head banging, shivering, breath holding, gasping, severe splinting</td>
</tr>
<tr>
<td>Cry</td>
<td>No cry (awake or asleep)</td>
<td>Moans or whimpers; occasional complaint, occasional verbal outbursts, constant grunting</td>
<td>Crying steadily, screams or sobs, frequent complaints, repeated outbursts, constant grunting</td>
</tr>
<tr>
<td>Consolability</td>
<td>Content, relaxed</td>
<td>Reassured by occasional touching, hugging or being talked to, distractable</td>
<td>Difficult to console or comfort, pushing caregiver away, resisting care or comfort measures</td>
</tr>
</tbody>
</table>
Pediatric Spine Surgery: Common Concerns

- Pain management
- Infection/complication prevention
- Nutrition
- Activity restrictions
- etc…
How Can We Measure Outcomes?
Gold standard?

PFTs difficult in NM and EOS
- Cooperation
- Effort
- Techniques
Radiographic-Traditional Measurements

Traditional study group measurements
- 2D measurements
- T1-T12, T1-S1 length, Cobb, etc.

Advantages
- Easily available

Disadvantages
- 2D, static, not normalized to growth
Do 2D Measurements Correlate With Pulmonary Function?

2D measurements correlate poorly w/ PFTs

– Not surprising!
– Chest is a dynamic 3D structure
Radiographic—Better Measurements?

True spine length?
- Growth friendly constructs pro-kyphotic
- Growth out of coronal plane
- 3D techniques/EOS

More accurate…but better?
- Still a static measure
Is 3D Better?

Advantages
- 3D volumes quantifies
  - Chest volume
  - Effect of treatment

Disadvantages
- Relationship to PFTs?
  - You can make the box bigger…
  - Still a static measure
Dynamic 3D MRI

Advantages
- Dynamic
  - Chest wall
  - Diaphragm

Disadvantages
- Early experience
- Sedation concerns
Elevated Hgb preop (15-23%):
- Hgb decreases w/ treatment

Normal Hgb preop:
- No change in Hgb

Emans et al, Skaggs et al, Glotzbecker et al
Elevated Hgb in small percentage (18%) of EOS

Respond to treatment when elevated

Useful in subset of younger, sicker patients?

*Are there better surrogates?*
QOL (EOSQ-24)

Early Onset Scoliosis Questionnaire

Advantages:
- Good to excellent agreement
- Correlated with PFTs

Disadvantages:
- Early experience
- Parent vs patient reported outcomes
- Others: SRS, PODCI, CHQ

Domains Tested

| General health |
| Pain/Fatigue |
| Pulmonary function |
| Transfer |
| Physical function |
| Daily living |
| Fatigue/Energy level |
| Emotion |
| Parental Burden |
| Financial Burden |
Quality of Life

No studies assessing QOL in NM EOS

Parent reporting bias
- Guilt of putting patient through procedure
- Clouds outcomes in NM scoliosis
What About Function?
What About Function?

Oxygen consumption testing
6 minute walk test
EOSQ functional domains
ASKp (Activities Scale for Kids performance)

Challenges in:
– Young kids
– Neuromuscular

Fig. 1. A patient with EOS completing the graded exercise testing protocol.
Conclusions
Conclusions

How do we define outcome?
- At best we have a bunch of surrogates
- Probably involves some combination
- May be different for different populations

We make children different (taller, straighter)
.......but better?

We are still searching!